Attorney's Docket No. U 011574-0

CHAPTER II

TRANSMITTAL LETTER TO THE UNITED STATES ELECTED OFFICE (EO/US)

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FI96/00359	20 JUNE 1996	26 JUNE 1995 etc.

TITLE OF INVENTION
AN EXTRUSION APPARATUS AND METHOD, A TUBULAR PRODUCT, AND A PIPE

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Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231

ATTENTION: EO/US

NOTE: The completion of those filing requirements that can be made at a time later than 30 months from the priority date results from the Commissioner exercising his judgment under the authority granted under 35 USC 371(d). The filing receipt will show the actual date of receipt of the last item completing the entry into the national phase. See 37 CFR 1.491 which states: "An international application enters the national state when the applicant has filed the documents and fees required by 35 USC 371(c) within the periods set forth in § 1.494 and § 1.495."

***WARNING:** Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 CFR 1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing - 37 CFR 1.8 (2) (xi)).*

NOTE: Documents and fees must be clearly identified as a submission to enter the national state under 35 USC 371 otherwise the submission will be considered as being made under 35 USC 111. 37 CFR 1.494(f).

CERTIFICATION UNDER 37 CFR 1.10

I hereby certify that this Transmittal Letter and the papers indicated as being transmitted therewith is being deposited with the United States Postal Service on this date DEC. 18, 1997, in an envelope as "Express Mail Post Office to Addressee" Mailing Label Number EI528037959US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

JENNIFER RASHKIN

(type or print name of person mailing paper)

Jennifer Rashkin

Signature of person mailing paper

NOTE: Each paper or fee referred to as enclosed herein has the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 CFR 1.16(b).

***WARNING:** Certificate of mailing (first class) or facsimile transmission procedures of 37 CFR 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.*

I. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. 371:

a. [X] This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).

b. [X] The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees (37 CFR 1.492) as indicated below:

2. Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
☐*	TOTAL CLAIMS	40 −20=	20	× $22.00=	$ 440.00
	INDEPENDENT CLAIMS	3 −3=	0	× $80.00=	0.00
	MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+$260.00	
BASIC FEE**	☐ U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: ☐ and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(1) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) ..... $96.00 ☐ and the above requirements are not met (37 CFR 1.492(a)(1)) ..... $700.00 ☒ U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: ☐ has been paid (37 CFR 1.492(a)(2)) ..... $770.00 ☒ has not been paid (37 CFR 1.492(a)(3)) ..... $1070.00 ☐ where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) $910.00				
	Total of above Calculations				= 1,070.00
SMALL ENTITY	Reduction by 1/2 for filing by small entity, if applicable. Affidavit must be filed also. (note 37 CFR 1.9, 1.27, 1.28)				−
	Subtotal				
	Total National Fee				$ 1,070.00
	Fee for recording the enclosed assignment document $40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				
TOTAL	Total Fees enclosed				$ 1,070.00

NOT PAID AT THIS TIME

*See attached Preliminary Amendment Reducing the Number of Claims.

i. ☒ A check in the amount of 1,070.00 to cover the above fees is enclosed.

ii. ☐ Please charge Account No. _____ in the amount of $ _____. A duplicate copy of this sheet is enclosed.

***WARNING:** *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 CFR § 1.495(b).*

WARNING: *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 CFR § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of January 3, 1993, 1147 O.G. 29 to 40.*

3. ☒ A copy of the International application as filed (35 U.S.C. 371(c)(2)):

NOTE: Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment. "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of January 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.

a. ☒ is transmitted herewith.

b. ☐ is not required, as the application was filed with the United States Receiving Office.

c. ☐ has been transmitted

i. ☐ by the International Bureau.
Date of mailing of the application (from form PCT/1B/308): _____.

ii. ☐ by applicant on (date) _____.

4. ☒ A translation of the International application into the English language (35 U.S.C. 371(c)(2)):

a. ☒ is transmitted herewith.

b. ☐ is not required as the application was filed in English.

c. ☐ was previously transmitted by applicant on (*date*) _____.

d. ☐ will follow.

5. ☒ Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3)):

NOTE: The Notice of January 7, 1993 points out that 37 CFR § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.

a. ☐ are transmitted herewith.

b. ☐ have been transmitted

i. ☐ by the International Bureau.
Date of mailing of the amendment (from form PCT/1B/308): _____.

ii. ☐ by applicant on (date) _____.

c. ☒ have not been transmitted as

i. ☒ applicant chose not to make amendments under PCT Article 19.
Date of mailing of Search Report (from form PCT/ISA/210.): _____.

ii. ☐ the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. ☒ A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. 371(c)(3)):

a. ☐ is transmitted herewith.

b. ☐ is not required as the amendments were made in the English language.

c. ☒ has not been transmitted for reasons indicated at point 5c above.

7. ☒ A copy of the international examination report (PCT/IPEA/409)

☒ is transmitted herewith.

☐ is not required as the application was filed with the United States Receiving Office.

8. ☒ Annex(es) to the international preliminary examination report

a. ☒ is/are transmitted herewith.

b. ☐ is/are not required as the application was filed with the United States Receiving Office.

9. ☒ A translation of the annexes to the international preliminary examination report

a. ☒ is transmitted herewith.

b. ☐ is not required as the annexes are in the English language.

10. ☒ An oath or declaration of the inventor (35 U.S.C. 371(c)(4)) complying with 35 U.S.C. 115

a. ☐ was previously submitted by applicant on (date) _____.

b. ☐ is submitted herewith, and such oath or declaration

i. ☐ is attached to the application.

ii. ☐ identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3b or 3c and 5b; and states that they were reviewed by the inventor as required by 37 CFR 1.70.

iii. ☒ will follow.

II. Other document(s) or information included:

11. ☒ An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):

a. ☒ is transmitted herewith.

b. ☐ has been transmitted by the International Bureau.
Date of mailing (from form PCT/IB/308): _____.

c. ☐ is not required, as the application was searched by the United States International Searching Authority.

d. ☐ will be transmitted promptly upon request.

e. ☐ has been submitted by applicant on (date) _____.

12. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98:

a. ☐ is transmitted herewith.

Also transmitted herewith is/are:

☐ Form PTO-1449.

☐ Copies of citations listed.

b. ☒ will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. 371(c).

c. ☐ was previously submitted by applicant on (date) _____.

13. ☐ An assignment document is transmitted herewith for recording.

A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

_____

_____

_____

14. ☒ Additional documents:

a. ☒ Copy of request (PCT/RO/101)

b. ☒ International Publication No. WO 97/01429

i. ☒ Specification, claims and drawing

ii. ☐ Front page only

c. ☒ Preliminary amendment (37 CFR § 1.121)

d. ☒ Other
FORM PCT/IB/304: FORM PCT/IB/332: FORM PCT/ISA/206: FORM PCT/ISA/210: FOUR (4) SHEETS OF DRAWINGS (FORMAL).

15. ☒ The above checked items are being transmitted

a. ☒ before 30 months from any claimed priority date.

b. ☐ after 30 months.

16. ☐ Certain requirements under 35 U.S.C. 371 were previously submitted by the applicant on _____, namely:

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependant claims, to avoid unexpected high charges if extra claims are authorized.*

☒ The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No. 12-0425.

☒ 37 CFR 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 CFR § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.*

☐ 37 CFR 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.

☐ 37 CFR 1.17 (application processing fees)

WARNING: *While 37 CFR 1.17(a), (b), (c) and (d) deal with extensions of time under § 1.136(a), this authorization should be made only with the knowledge that: "Submission of the appropriate extension fee under 37 CFR 1.136(a) is to no avail unless a request or petition for extension is filed." Notice of November 5, 1985 (1060 O.G. 27).*

☒ 37 CFR 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 CFR 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 CFR 1.311(b).

NOTE: 37 CFR 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 CFR 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

☒ 37 CFR 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF ATTORNEY

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A tubular product and an extrusion apparatus and method

The invention relates to a tubular product comprising at least three layers, a base layer, an innermost layer made of plastic by continuous extrusion, the base layer and the innermost layer having poor adhesion to each other, and a tie layer between the base layer and the innermost layer.

The invention further relates to an extrusion apparatus comprising means for extruding a multilayer parison comprising at least an inner plastic layer and a tie layer.

The invention also relates to an extrusion method wherein a multilayer parison comprising at least an inner plastic layer and a tie layer is extruded.

In this type of extrusion apparatus, pressures are high and mechanical stresses are great in the nozzle section, i.e. in the area of the central extrusion conduit. The present structures also needlessly prevent some of the possibilities of use of the apparatus.

The purpose of the present invention is to eliminate this drawback. The tubular product according to the invention is mainly characterized in that tie layer is of foamed material at least in one intermediate layer.

Further, the extrusion apparatus according to the invention is characterized in that the tie layer of foamed material and that the apparatus is arranged inside a tubular base layer and comprises an expanding madrel for forcing the inner layer and the tie layer against the base layer.

Also, the extrusion method according to the invention is characterized in that the tie layer of foamed material and that the plastic layer and the tie layer of foamed material are extruded inside a tubular base layer and forced against the base layer by an expanding mandrel.

With the nozzle construction according to the invention which expands outwards and in which the feed gap enlarges after it has contracted, the pressure acting on the structures of the extrusion apparatus can be considerably balanced, i.e. the apparatus can be made more durable.

Also, especially if the feed gap opens on the outer circumference of the extrusion apparatus or near it, it is highly preferable that an actuator provided for each rotor and the means of the actuator driving the rotor are placed at the back of the extrusion apparatus in such a way that the actuator is positioned in the radial direction of the extrusion apparatus within the outlines determined by the other components of the extrusion apparatus. In such a case, the extrusion apparatus can be easily made such that the nozzle section determines the outer dimensions of the entire extrusion apparatus in the radial direction, whereupon the possibilities of use of the apparatus increase considerably.

A new possibility presents itself for example when the extrusion apparatus is connected to operate together with a corrugator used for preparing for example corrugated pipes, and the extrusion apparatus can be placed inside the corrugator altogether. At present, material must be fed into the corrugator with a long nozzle, so that the material travels in the apparatus for a long time and a great amount of stabilizer is needed. When used with a corrugator, the extrusion apparatus can also be formed with a double cone structure in order to manufacture a two-layer corrugated pipe.

Placing the actuator(s) at the back of the extrusion apparatus also enables the use of the apparatus at the rear of a hole-making machine for example underground, whereupon the extrusion apparatus is arranged to prepare a plastic pipe in the hole made by the machine. The fact that it is very easy to construct the conical extruder in such a way that there is a considerable hole

through the extruder makes the connection to the hole-making machine easy. Another new possibility results from the fact that the extrusion apparatus can also be used for coating e.g. steel pipes from the inside. In such a case, the inner surface of a steel pipe can be simultaneously coated with thermally insulating adhesion plastic and with an inner layer made of for example PEX placed inside the adhesion plastic. Such pipes can be joined for example with a cross-linked plastic sleeve.

In all embodiments where the actuators are situated at the back of the extrusion apparatus, the supply of the plastic material to the apparatus must naturally also be arranged from the rear.

In the following, the invention will be described in greater detail with reference to the accompanying drawings, in which

Figure 1 is a cross-sectional side view of a simple embodiment of an extrusion apparatus provided with a radially expanding nozzle section,

Figure 2 is a cross-sectional side view of another embodiment of an extrusion apparatus where the rotating mechanisms for the rotors are placed at the back of the extrusion apparatus,

Figure 3 is a cross-sectional side view of a third extrusion apparatus placed inside a corrugator,

Figure 4 shows a detail of the apparatus of Figure 3,

Figure 5 shows an extrusion apparatus moving at the rear of an underground hole-making machine and preparing a plastic pipe in the hole made by the machine,

Figure 6 is a cross-sectional view of a pipe coated with the apparatus of Figure 5,

Figure 7 is a cross-sectional side view of a fourth extrusion apparatus according to the invention,

Figure 8 shows a detail of the apparatus of Figure 7,

Figure 9 shows the coating of a pipe from the

outside and the inside with two different extrusion apparatuses, and

Figure 10 shows the coating of a pipe positioned in place from the inside with an extrusion apparatus,

Figure 1 shows a simple extrusion apparatus for extruding plastic material, in which case the plastic material is fed into the apparatus either in a fixed, preferably powdery or granular, form or either entirely or partly melted. This extrusion apparatus comprises an outer stator 1, a rotor 2, an inner stator 6, an annular feed gap 3 situated between the outer stator 1 and the rotor 2, and correspondingly another annular feed gap 3 situated between the inner stator 6 and the rotor 2 for the plastic material to be extruded, and an actuator 5 for rotating the rotor 2.

The rotor 2 is conical, and the surfaces of the stators 1 and 6 are conical at least on the side of the rotor 2, i.e. at least the inner surface of the outer stator 1 and the outer surface of the inner stator 6 are conical. The actuator 5 comprises a motor and for example a pinion system or a gear system. The motor may be for example a hydraulic motor, an electric motor or some other motor that is known per se and that is suitable for the purpose. Hydraulic drive is particularly advantageous for example when the extrusion apparatus is used in connection with an underground hole-making machine, in which case the hole-making machine and the extrusion apparatus may share the power supply. If the actuator 5 comprises a gear system, the speed of rotation of the rotor 2 can be adjusted with the system in a desired manner. On the other hand, for example when an electric motor is used the gear system is not necessary, since the speed of rotation of the rotor 2 can be regulated easily by adjusting the speed of rotation of the motor in a manner known per se.

The extruder further comprises a supply conduit 7 along which the material to be extruded can be fed into the feed gap 3. The material to be fed into the supply

conduit 7 is supplied by a feeding device 8. The feeding device 8 can be for example a feed screw, a pump or some other device known per se. With the feeding device, the flow rate of the material to be fed into the supply conduit can be adjusted. The material to be supplied can be conducted from the supply conduit 7 to the feed gap 3 between the outer stator 1 and the rotor 2. The rotor 2 further comprises openings 9 via which some of the material situated in the supply conduit 7 can flow into the interior of the rotor 2 into the feed gap 3 between the inner stator 6 and the rotor 2. It is also possible to use separate supply conduits and feeding devices for separately feeding the material to be supplied into the exterior and interior of the rotor 2 in a manner known per se. When the rotor 2 is rotated, the material to be extruded flows in the direction of flow A in the extrusion apparatus by the action of grooves provided in the rotor 2 and/or in the stators. For the sake of clarity, these grooves are not shown in the figure.

The diameter of the annular feed gap 3 decreases at first continuously in the direction of flow A of the plastic material to be extruded, and the feed gap comprises firstly a feed zone 3a, then a melting zone 3b and at the end a compression zone 3c in the aforementioned direction of flow A. After the rotor 2, the feed gaps 3 provided on different sides of the rotor 2 come together as one feed gap 3. In order to balance the pressures P and the stresses, the diameter of the central feed gap 3 correspondingly increases continuously at a section of the length of the gap in the direction of flow A of the plastic material to be extruded after the feed gaps 3 from the different sides of the rotor 2 have come together as one feed gap 3. In this exemplary embodiment, the diameter of the feed gap 3 increases linearly immediately after the rotor 2, and the end section of the gap has a constant diameter, i.e. the gap is parallel with the central axis of the extrusion apparatus.

Figure 2 is a cross-sectional side view of a second extrusion apparatus according to the invention. The reference numerals in Figure 2 correspond to those in Figure 1. The extruder according to Figure 2 comprises two conical rotors, an outer rotor 2a being placed between an outer stator 1 and an intermediate stator 10 and an inner rotor 2b being placed between an inner stator 6 and the intermediate stator 10. For the sake of clarity, the figure does not show grooves provided in the rotors and/or the stators. An actuator 5 is arranged to rotate the rotors 2a and 2b. The speeds of rotation of the rotors 2a and 2b can be adjusted differently, if desired, and/or their speeds of rotation can be made adjustable independently of each other. Material is supplied to feed gaps 3 situated on the outside and inside of the outer rotor 2a by means of a supply conduit 7 and a feeding device 8. Correspondingly, material is supplied to the interior of the inner rotor 2b and via openings 13 to the exterior of the rotor by means of a second supply conduit 11 and a second feeding device 12.

The feed gap 3 opens on the outer circumference of the extrusion apparatus. The actuator 5 and the feeding devices 8 and 12 are placed at the back of the extrusion apparatus in such a way that they are positioned in the radial direction of the extrusion apparatus within the outlines determined by the outermost point of the feed gap 3 of the extrusion apparatus, this outer circumference being denoted in the accompanying figure by Øu.

Figure 3 shows a third extrusion apparatus according to the invention placed inside a corrugator. The reference numerals in Figure 3 correspond to those in Figures 1 and 2. The corrugator comprises chill moulds 14 that move forward and that have a grooved inner surface against which the plastic mass 15 is pressed in order to prepare a ribbed pipe. Since the structure of the corrugator is known per se, it will not be discussed in greater detail in this connection. The feeding device 8

and the actuator 5 for rotating the rotor 2 are placed at the back of the extrusion apparatus in such a way that they are positioned in the radial direction inside the outermost part of the feed gap 3, i.e. inside the outer circumference Øu. The extrusion apparatus can then be placed inside the corrugator, and there is no need for long nozzles where the plastic mass 15 easily cools too much before arriving at the grooves of the chill moulds 14. The initial section of the rotor 2 has the shape of a tapering cone and the end section of the rotor has the shape of an expanding cone. The rotor 2 thus forms on each side separate feed gaps 3 that extend to the outer circumference Øu of the extrusion apparatus. The rotor 2 comprises grooves 4 that transport the material to be extruded out from the extruder. However, at the end of the rotor 2 there is a smooth area comprising no grooves. The material to be extruded thus forms a smooth flow and comprises substantially no seams produced by the grooves. Further, the groove-free area produces and maintains a helical orientation field. This orientation is frozen into the product when the parison to be extruded meets the chill moulds.

At the bottoms of the grooves of the chill moulds 14, there are suction ducts 16 the suction of which ensures that the plastic mass 15 reaches all the way to the bottom of the grooves of the chill moulds 14. Further, by suitably conducting the material flows of the plastic mass 15 flowing on different sides of the rotor 2, it is possible to produce a pipe comprising openings 17 at the grooves of the chill moulds. The extrusion apparatus further comprises a mandrel 18, and the plastic pipe is formed as the chill moulds 14 and the mandrel 18 press the plastic pipe preform from different sides.

Figure 4 shows a detail of the apparatus of Figure 3. The reference numerals in Figure 4 correspond to those in Figures 1 to 3. Figure 4 shows clearly how the apparatus produces an opening 17 in the corrugated pipe.

The plastic mass flows 15a and 15b are conducted in such a way that the plastic pipe to be extruded will comprise two layers. Instead of the suction ducts 16, the opening 17 could be formed by means of blowing that is arranged to blow air or some other suitable gas through the rotor 2 in order to produce the opening 17.

Figure 5 shows schematically an extrusion apparatus according to the invention placed in connection with an underground hole-making machine. The hole-making machine 20 is arranged to make a hole in the soil 21. The extrusion apparatus 19 in turn is arranged to move in connection with the hole-making machine 20 and to simultaneously produce a plastic pipe 22 in the hole made by the hole-making machine 20. The control and actuator connections 23 of the hole-making machine 20 can be made to pass through the hollow extrusion apparatus 19. For the sake of clarity, Figure 5 does not show the means required for moving the hole-making machine 20 and the extrusion apparatus 19.

Figure 6 shows a steel pipe which is coated with plastic from the inside and in which the layer situated against the steel 24 is thermally insulating adhesion plastic 25 and the second layer is cross-linked polyethylene, i.e. PEX 26. The adhesion plastic 25 can be for example grafted polyethylene. The adhesion plastic 25 is preferably foamed. When the steel pipe is coated from the inside, the coating plastic is hot in the beginning so that its diameter remains large, whereas when the plastic cools the diameter of the plastic layer tends to decrease. The foamed adhesion plastic 25 sticks to the surface of the steel pipe but allows the inside to shrink. In such a case, the foam bubbles stretch in the radial direction, i.e. the foam bubbles are oriented radially, which increases the strength of the pipe. The foamed adhesion plastic 25 comprises preferably at least 10%, most preferably about 25%, of fine filling agent, such as calcium carbonate. The elastic modulus of the foam can

thus be made high, i.e. the structure will be strong. Further, the foamed adhesion plastic 25 is a very good heat insulator against the PEX 26. On the other hand, when a steel pipe is coated from the inside, the orientation of the plastic pressed inside can be frozen efficiently, since the steel pipe cools the pipe effectively from the outside. When steel pipes coated in this manner are to be joined together, for example a cross-linked plastic sleeve 27 that is compressed and warmed in place can be used. The cross-linked plastic sleeve 27 tends to return to the size of the diameter preceding the compression, and the expansion is provided by means of heating. The joint will then be extremely tight. It is also possible to use for the joint a sleeve 28 that is provided in the outside with mastic or some other adhesive with which the sleeve 28 can be made to stick to the pipe. Electrofusion can also be used. At the outside of the joint, it is possible to place a clamping collar 29 that is made of a strong material and that can be positioned to rest on a metal casing, such as steel 24. The clamping collar 29 receives axial tensile forces. The joint can also be implemented by welding, so that the adhesion plastic 25 acts as a good heat insulator against the innermost layer. The coating of steel pipes can be realized by applying the principle shown in Figure 5. Other metal pipes and concrete pipes can also be coated in a similar manner.

Figure 7 is a cross-sectional side view of an extrusion apparatus according to the invention. The reference numerals in Figure 7 correspond to those of Figures 1 to 6. The extrusion apparatus of Figure 7 comprises one fixed stator, an intermediate stator 10. At the outside of the stator there is a rotatable outer rotor 2a and at the inside there is a rotatable inner rotor 2b. The surface of the intermediate stator 10 on the side of the outer rotor 2a is conical and correspondingly the surface of the outer rotor 2a on the side of the intermediate stator 10 is conical. The intermediate stator

10 comprises grooves 4 that transport the material to be extruded between the intermediate stator 10 and the outer rotor 2a out of the extrusion apparatus as the outer rotor 2a rotates. According to a corresponding principle, the inner rotor 2b comprises grooves that transport the plastic material to be extruded out of the extrusion apparatus as the inner rotor 2b rotates. For the sake of clarity, the accompanying figure only shows an actuator 5 rotating the outer rotor 2a. For the inner rotor 2b there may be one or several actuators. It is also possible to place one common actuator to rotate both the outer rotor 2a and the inner rotor 2b, whereupon each rotor is rotated by the same pinion so that the rotors naturally rotate in opposite directions. If each rotor has its own actuator, the directions of rotation of the rotors can naturally be selected to be the same or opposite. The inner rotor 2b is followed by a rotatable expansion cone 30. The expansion cone 30 is rotated with a rotating means 31. With the rotating means 31 the expansion cone 30 can be rotated either at the same or a different speed with the inner rotor 2b in the same or different direction according to the desired orientation. The extrusion apparatus according to the invention is arranged to prepare the innermost pipe of a multilayer pipe and the apparatus comprises means for producing the outer layer of the pipe, the means preparing the outer layer by winding a strip 32 spirally into a pipe. These means are not shown in the figure for the sake of clarity. The extrusion apparatus of Figure 7 makes the plastic mass 15 of the inner pipe move in a rotating manner so that the layers can be caused to stick together very well. The mandrel 18 may also be cooled, so that as the strip 32 and the mandrel 18 cool the plastic mass 15, the orientation of the mass can be frozen very efficiently. The strip 32 may be made of for example glass fibre or it may be a polypropylene strip oriented in one direction.

The strip 32 preferably consists of an outer

electrode layer 32a, an insulating layer 32b and an inner electrode layer 32c. The outer electrode layer 32a can be made of for example electrically conductive plastic or aluminium foil. The insulating layer 32b can be for example sintered or normal foamed plastic the cells of which comprise for example a filler. The foamed plastic is preferably contains holes so that for example air passes through it. The inner electrode layer 32c can have a similar structure as the outer electrode layer 32a. The above-described manner provides a pipe that can be used for example in such a way that as a nail passes through the pipe, a short circuit occurs between the electrode layers and the pipe warns the user of a serious breakdown. The pipe can be used for example as a gas pipe inside a building. On the other hand, a potential difference can be created between the electrode layers, whereupon as the surface of the pipe is pressed in some place for example by a stone, the change in the potential difference of the insulating layers can be detected by a voltmeter. The application of the pipe is useful for example when laying the pipe in the ground, and for example problems caused by an excessive traffic load can be taken into account in such a situation. In the same way, it is possible to detect an excessive increase of the pressure inside the pipe. The alarm levels of the pipe can be determined easily by adjusting the outside ring stiffness of the pipe with respect to the inside stiffness and to the hardness of the foam. On the other hand, when the pipe is used as a ventilation or a soil and waste pipe inside a building, noise of the sewer in the pipe can be detected and a counter-wave can be correspondingly produced in the outside to muffle the noise occurring in the pipe. Further, it is possible to use the outer surface to produce a sound, for example a warning signal. The potential difference between the electrode layers can also be used as a moisture barrier, so that water molecules cannot corrode the surface of the pipe. Correspondingly,

when the insulating layer becomes damp, it affects the potential difference, wherefore the pipe can be used as a sensor for locating leakages for example in district heating pipes. The strength of the pipe is also excellent for example when aluminium is used for the electrode layer. The electrode layers can naturally be used for example for electrically heating or for locating the pipe, since for example aluminium can be easily detected from the ground by means of e.g. a metal detector. On the other hand, sound signals can also be supplied to the electrodes and the audible sound can be used to facilitate the location. The insulating or insulation foam layer situated between the electrodes can also be modified for example with carbon black so that it is partially conductive, whereupon the compression of the insulator directly affects for example the potential difference. The application for use in sprinklers is also possible since the fast warming of the metal foil affects the electric connection between the films. Due to its great strength originating from the combination of metal and oriented plastic and the possibilities of using alarm signals, the pipe is also applicable for offshore gas and oil pipes and for large trunk lines, for instance. It seems possible that by feeding high-frequency oscillation into a pair of electrodes, bacterial growth on the outer and/or inner surface of the pipe can be prevented.

The electrode layers can be positioned in such a way that the outer electrode layer 32a is more rigid, whereupon the pipe reacts mainly to signals arriving from the inside, or in such a way that the inner electrode layer is more rigid, whereupon the pipe reacts mostly to signals from the outside.

The apparatus of Figure 7 can also be arranged to rotate as a whole by mounting the extrusion apparatus in bearings from the end so that it rotates, whereupon for example the accumulation of tolerances can be avoided in the manufacture of films. In this case, the material of

the tubular product comes out from the extruder rotating, and naturally the haul-off must be of rotating type too. There may be wedges 43 outside the apparatus, the outer rotor 2a being moved in the radial direction by means of the wedges. In this way, the thickness of the outer layer of the plastic material 15 produced by the apparatus can be adjusted. The rotating cone 30 can be made axially movable, whereupon by changing the place of the rotating cone 30 it is possible to adjust the thickness of the inner layer of the material 15 to be extruded. By feeding the material to be extruded with separate supply conduits to different sides of the intermediate stator 10, the material flow can be adjusted by means of the feeding devices so that the material flows to be supplied to each side determine the thicknesses of the different layers. The outer rotor 2a, the inner rotor 2b and the expansion cone 30 preferably rotate in the same direction, whereupon the plastic material to be extruded is wound tightly together with the strip 32 to be supplied and the pipe to be extruded will form an even construction. The intermediate stator 10 comprises electric resistors 44, whereupon the material to be extruded can be heated mainly from the middle of the material through the intermediate stator 10, so that the heating can be realized effectively.

Figure 8 shows a detail of the apparatus of Figure 7. The reference numerals in Figure 8 correspond to those in Figures 1 to 7. In the case of Figure 8, instead of the strip 32, an aluminium strip 33 is supplied to form the outer layer. The aluminium strip 33 can be attached to the adjacent aluminium profile in the spiral formed by the strip for example by means of a continuous weld, spot welding or gluing or in some other manner known per se. The aluminium strip 33 may also comprise grooves as shown in Figure 8. In such a case, the diameter Ør of the outermost supply flow of the mass 15 to be supplied is made preferably greater than the smallest inner diameter

ØA1 of the aluminium profile 33, whereupon the compression of the plastic mass 15 to the bottom of the grooves can be ensured and a very strong aluminium-coated plastic pipe can be manufactured. Instead of a flat aluminium profile, the profile can be of plastic material having e.g. a hollow square cross-section which will greatly enhance the ring stiffness of the pipe. This type of stiff pipe with an inside liner oriented with tensile strength can be used for example in pressure sewage applications.

Figure 9 shows yet another application of an extrusion apparatus according to the invention. The reference numerals in Figure 9 correspond to those in Figures 1 to 8. A plastic layer is supplied by the extrusion apparatus 19 to the interior of the pipe to be made of the aluminium strip 33. A plastic layer 35 is then supplied on the aluminium pipe with a second extrusion apparatus that is conical. The pipe to be prepared is pulled with a pulling device 36 in such a way that the plastic layer supplied with the extrusion apparatus 34 sticks to the surface of the pipe at a distance from the extrusion apparatus 34. The pulling device 36 can be rotatably connected. The pulling of the pipe to be prepared succeeds, since due to the layer made of aluminium or some other metal, the pipe stands stretching well. Axial orientation is thus produced in the plastic layer 35. The extrusion apparatus 19 provides inside the aluminium pipe a plastic layer comprising a circumferential orientation. A pipe is thus obtained that comprises an aluminium layer and inside the aluminium layer there is a circumferentially and/or axially oriented plastic layer and outside there is an axially oriented plastic layer, wherefore the resulting pipe is very strong.

Figure 10 schematically shows the use of an extrusion apparatus according to the invention for coating sewage pipes from the inside. The devices required can be installed underground for the interior coating of a sewage

pipe 38 via a first drain pit 37a and a second drain pit 37b. The extrusion apparatus 19 is moved in the sewage pipe 38 by pulling it with a cable wire 39. The cable wire 39 is wound on a reel 40. The cable wire 39 is guided by means of control rolls 41. In the case of Figure 10, the extrusion apparatus 19 is first pulled by the cable wire 39 near the first drain pit 37a. The extrusion apparatus is then set into action to produce a plastic pipe 22 and it is pulled with the cable wire 39 towards the second drain pit 37b. The supply of the material and energy to the extrusion apparatus 19 can be realized along a duct 42 from a unit situated on the ground. The extrusion apparatus 19 can naturally also be placed in such a way that it prepares the plastic pipe 22 in the opposite direction as viewed in Figure 10.

The invention is described above by means of only a few preferred embodiments. It is clear for a person skilled in the art, however, that the invention is not restricted to the above examples, but the different embodiments of the invention may vary within the scope of the appended claims. Therefore, the simplest form of the extrusion apparatus comprises only one fixed stator and one rotatable rotor between which there is a conical feed gap. The method and the apparatus according to the invention can naturally also be used for preparing for example oriented films or high-pressure pipes or hoses.

Claims

1. A tubular product comprising at least three layers, a base layer, an innermost layer made of plastic by continuous extrusion, the base layer and the innermost layer having poor adhesion to each other, and a tie layer between the base layer and the innermost layer, c h a r a c t e r i z e d in that the tie layer is of foamed material at least in one intermediate layer.

2. A tubular product according to claim 1, c h a r a c t e r i z e d in that the base layer consists of the soil in the ground.

3. A tubular product according to claim 1, c h a r a c t e r i z e d in that the base layer is made of metal of plastic-coated metal.

4. A tubular product according to claim 3, c h a r a c t e r i z e d in that the base layer comprises radial grooves or ribs.

5. A tubular product according to any one of the preceding claims, c h a r a c t e r i z e d in that the inner surface of the base layer is rough which is smoothened by the foamed tie layer and that the inner surfaces of the tie layer and innermost layer are substantially smooth.

6. A tubular product according to any one of the preceding claims, c h a r a c t e r i z e d in that the tie layer contains of fine filling agent.

7. A tubular product according to any one of the preceding claims, c h a r a c t e r i z e d in that the inner layer of the product is made of oriented plastic.

8. A tubular product according to any one of the preceding claims, c h a r a c t e r i z e d in that the tie layer comprises oriented foam bubbles.

9. A tubular product according to any one of the preceding claims, c h a r a c t e r i z e d in that the innermost layer and/or the tie layer is cross-linked polyethylene.

10. A tubular product according to any one of the preceding claims, c h a r a c t e r i z e d in that the

tie layer consists of grafted polyethylene.

11. A tubular product according to any one of the preceding claims, c h a r a c t e r i z e d in that the product is joined together with another similar product by means of a cross-linked plastic sleeve (27) that has a diameter compressed to a smaller size than normally.

12. A tubular product according to any one of claims 1 to 10, c h a r a c t e r i z e d in that the product is joined together with another similar product by means of a sleeve (28) situated inside the joint and a clamping collar (29) situated outside the joint.

13. An extrusion apparatus comprising means for extruding a multilayer parison comprising at least an inner plastic layer and a tie layer c h a r a c t e r i z e d in that the tie layer is of foamed material and that the apparatus is arranged inside a tubular base layer and comprises an expanding madrel for forcing the inner layer and the tie layer of foamed material against the base layer.

14. An extrusion method wherein a multilayer parison comprising at least an inner plastic layer and a tie layer is extruded, c h a r a c t e r i z e d in that the tie layer is of foamed material and that the plastic layer and the tie layer of foamed material are extruded inside a tubular base layer and forced against the base layer by an expanding mandrel.

Abstract

An extrusion apparatus and method, and a tubular product made of several different materials.

The extrusion apparatus according to the invention comprises at least one stator (1, 6, 10), at least one rotor (2, 2a, 2b), and at least one annular feed gap (3) situated between the stator (1, 6, 10) and the rotor (2, 2a, 2b). The diameter of the feed gap (3) decreases at least partly continuously in the direction of flow of the plastic material to be extruded, and its diameter also increases continuously at least at a section of its length in the aforementioned direction of flow. With such a construction, the pressure acting on the structure of the extrusion apparatus can be considerably balanced, i.e. the apparatus can be made more durable.

The invention also relates to a tubular product made of several different materials.

(Figure 1)

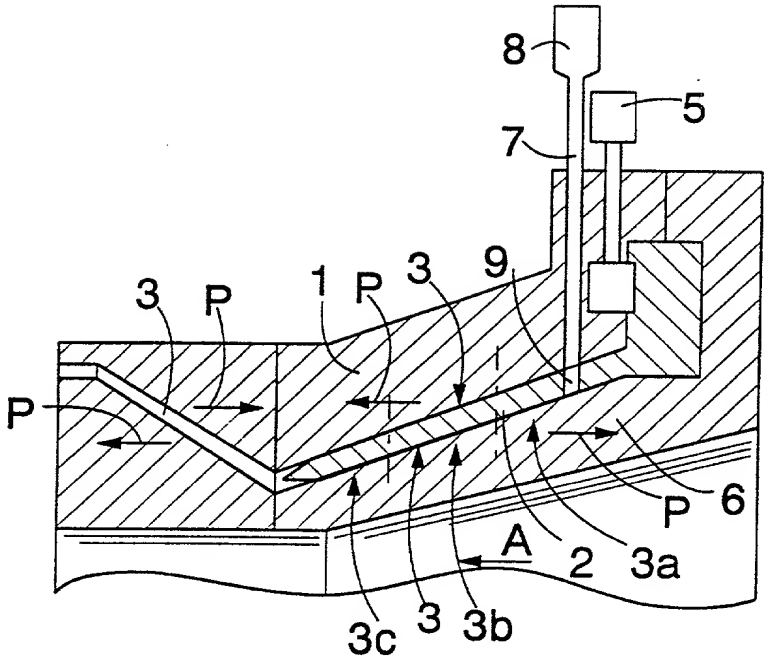

FIG. 1

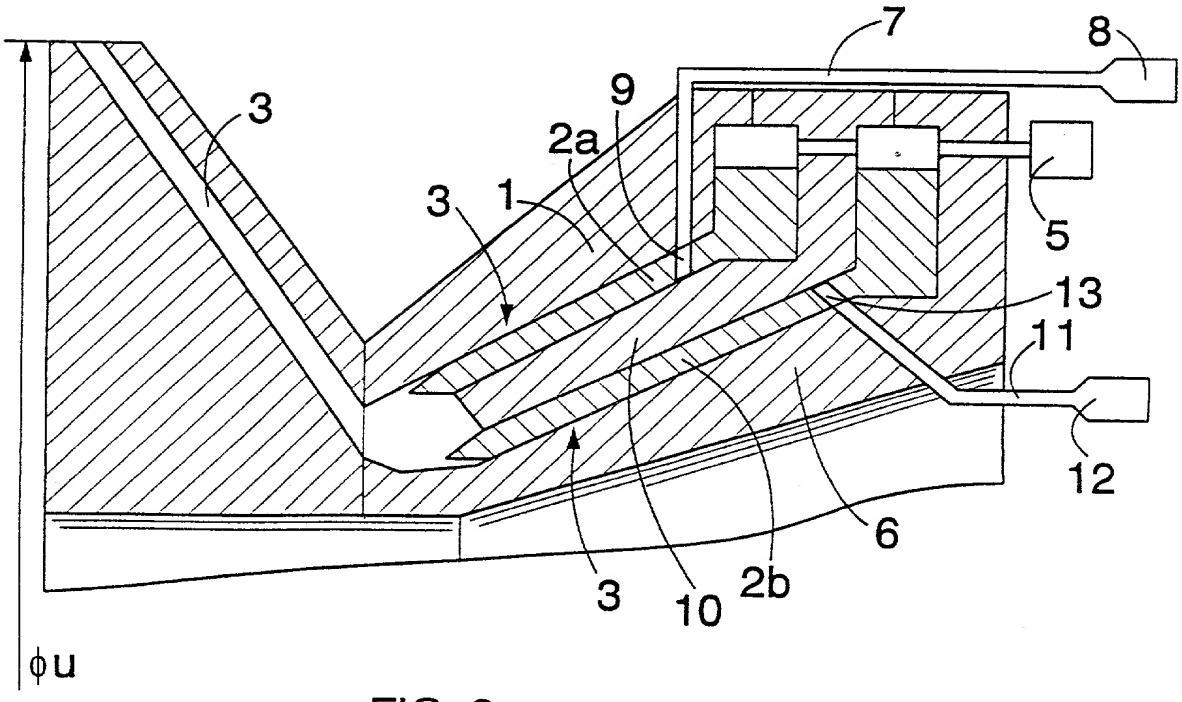

FIG. 2

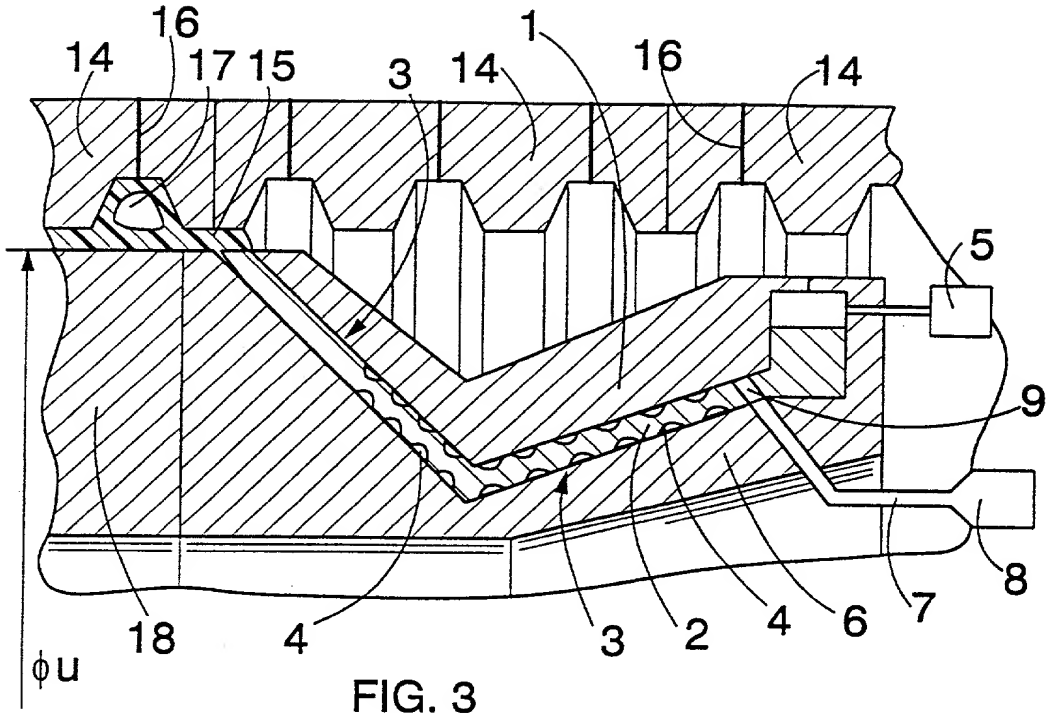

FIG. 3

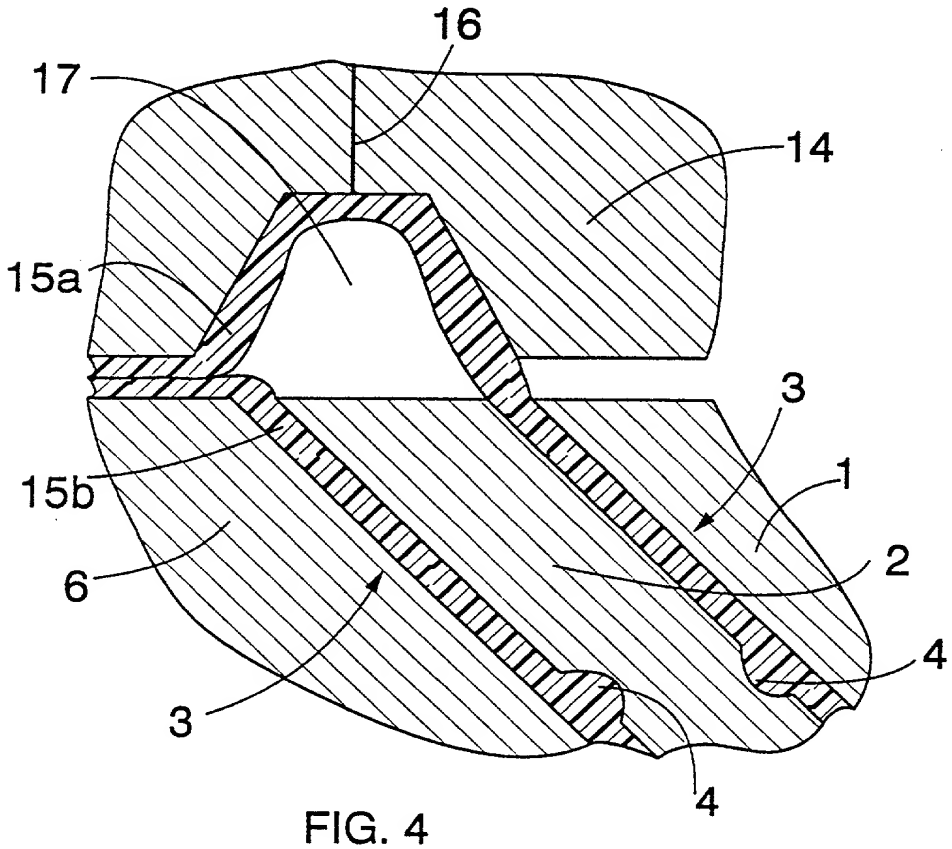

FIG. 4

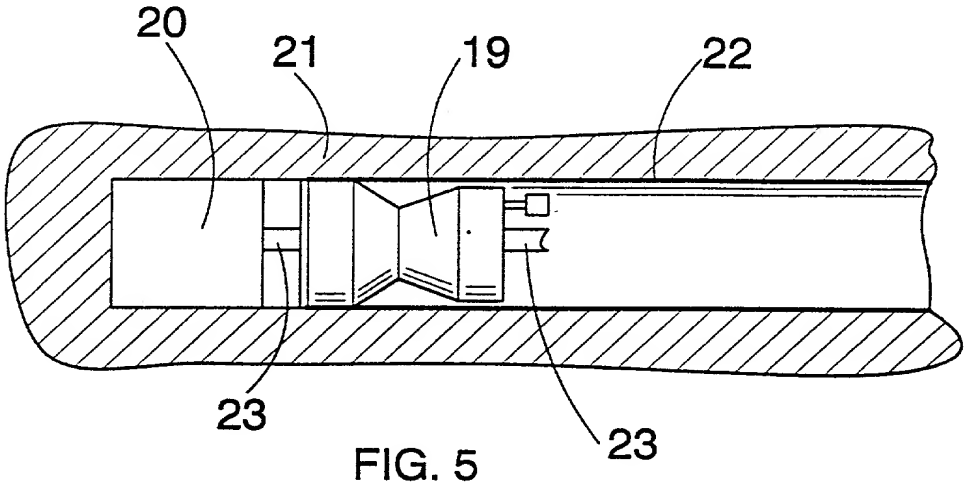

FIG. 5

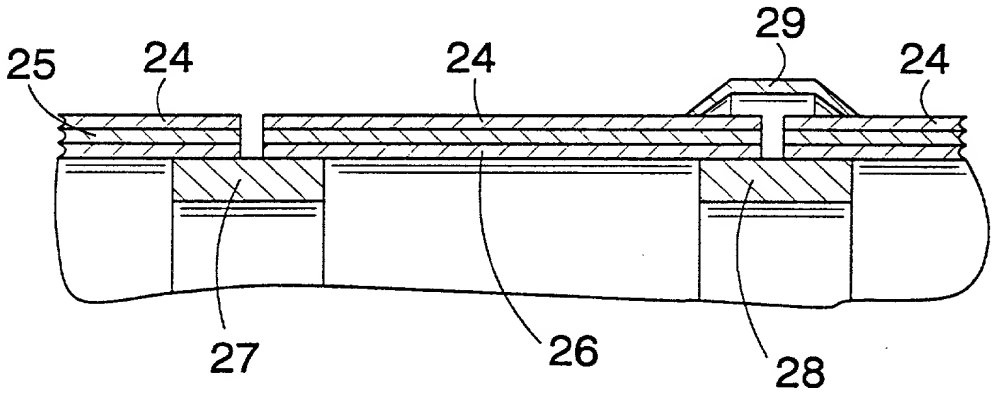

FIG. 6

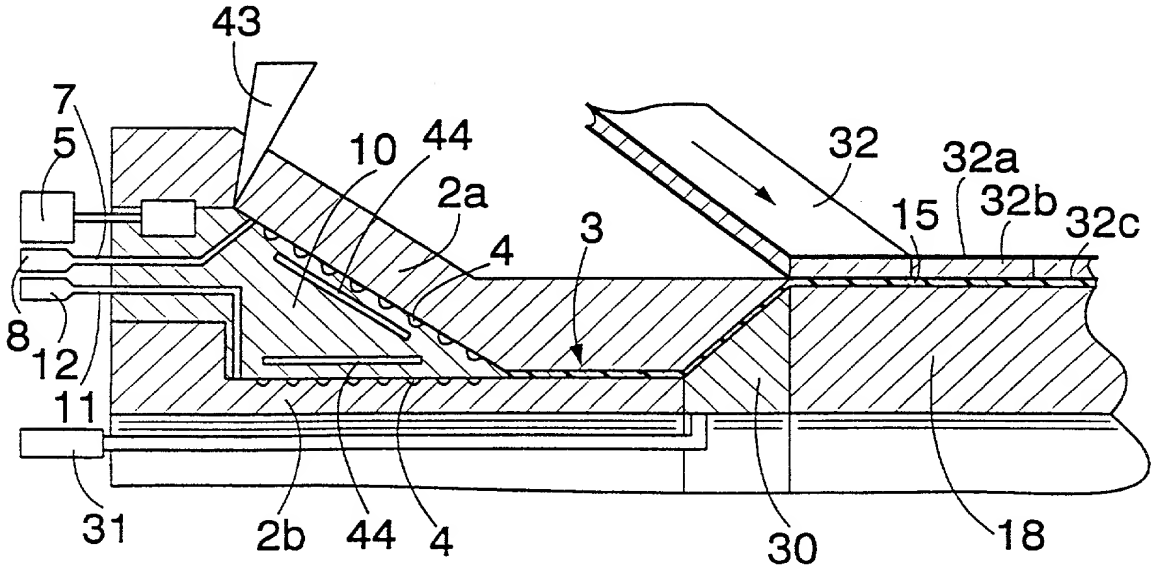

FIG. 7

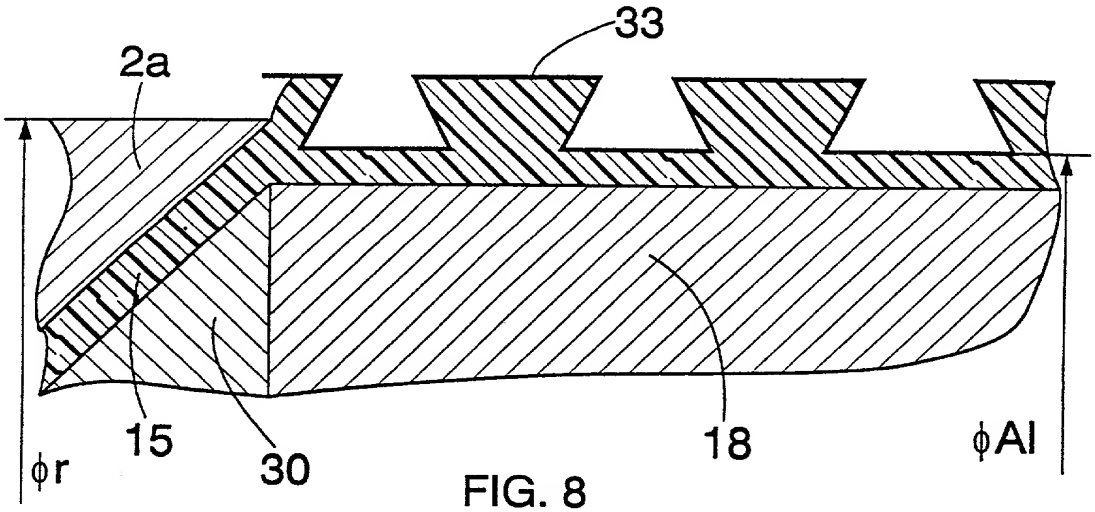

FIG. 8

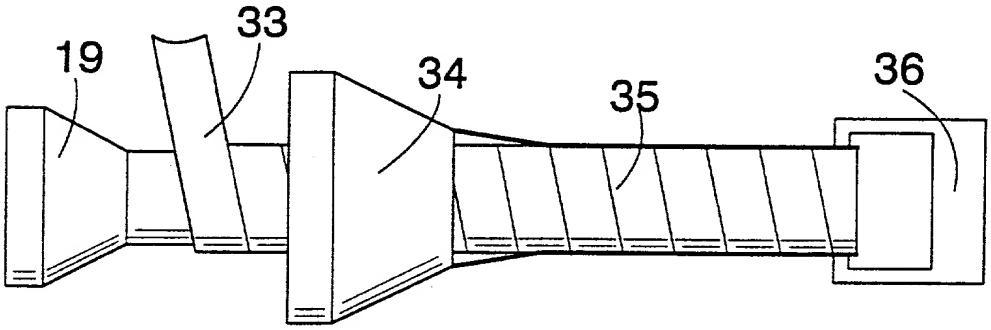

FIG. 9

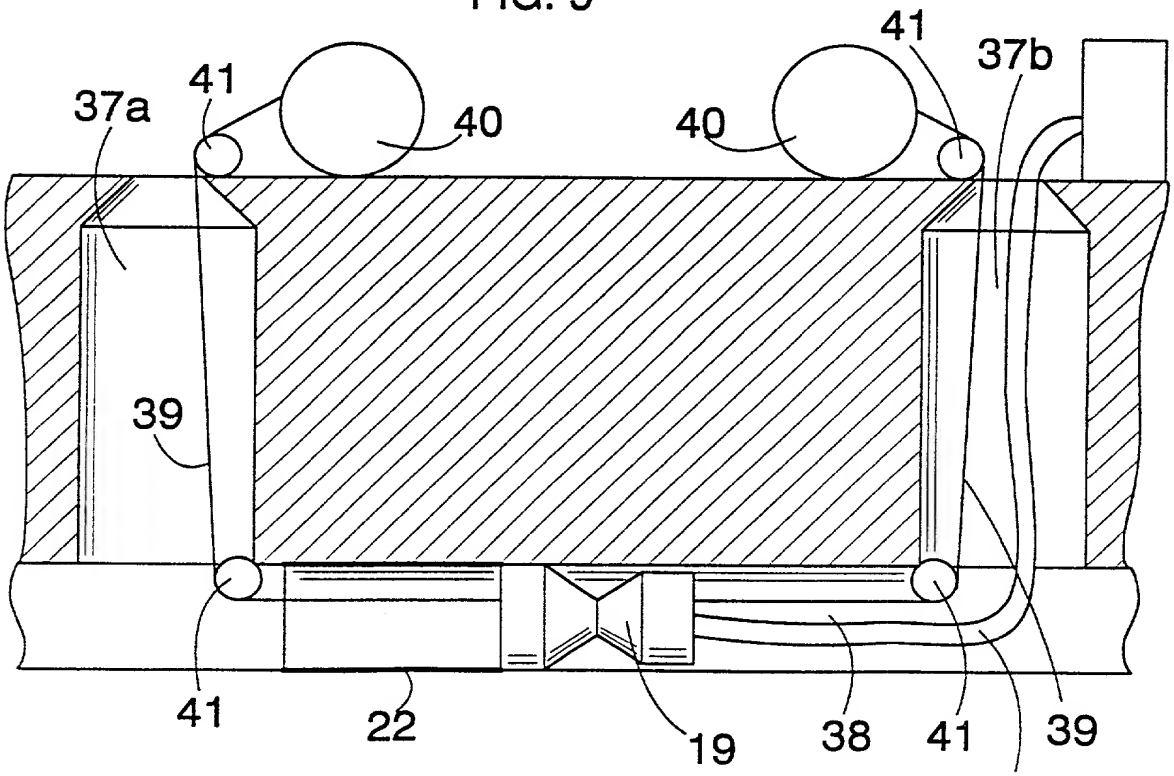

FIG. 10

Attorney's Docket No. U 011574-0 **PATENT**

COMBINED DECLARATION AND POWER OF ATTORNEY

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL, CONTINUATION OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type: (*check one applicable item below*)

- ☐ original
- ☐ design
- ☐ supplemental

NOTE: *If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of last three items.*

- ☒ national stage of PCT

NOTE: *If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.*

- ☐ divisional
- ☐ continuation
- ☐ continuation-in-part (C-I-P)

INVENTORSHIP IDENTIFICATION

WARNING: *If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.*

My residence, post office address and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

A tubular product and an extrusion apparatus and method

SPECIFICATION IDENTIFICATION

the specification of which: *(complete (a), (b) or (c))*

(a) ☐ is attached hereto.

(b) ☐ was filed on _____ as ☐ Serial No. 0 /_____
or ☐ Express Mail No., *as Serial No. not yet known* _____
and was amended on _____ (*if applicable*).

NOTE: *Amendments filed after the original papers are deposited with the PTO which contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 CFR 1.67.*

(c) ☒ was described and claimed in PCT International Application No. PCT/FI96/00359 filed on 20 June 1996 and as amended under PCT Article 19 on _____ (*if any*).

ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information

☒ which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56

(also check the following items, if desired)

☐ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable examiner would consider it important in deciding whether to allow the application to issue as a patent, and

☐ In compliance with this duty there is attached an information disclosure statement in accordance with 37 CFR 1.98.

PRIORITY CLAIM (35 U.S.C. § 119)

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

(complete (d) or (e))

(d) ☐ no such applications have been filed.

(e) ☒ such applications have been filed as follows.

NOTE: *Where item (c) is entered above and the International Application which designated the U.S. itself claimed priority check item (e), enter the details below and make the priority claim.*

A. PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 USC 119
Finland	953162	26/06/1995	☒ YES NO ☐
Finland	961822	29/04/1996	☒ YES NO ☐
Sweden	9503272-8	20/09/1995	☒ YES NO ☐
Finland	961540	04/04/1996	☒ YES NO ☐
			☐ YES NO ☐

ALL FOREIGN APPLICATION(S), IF ANY FILED MORE THAN 12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION

NOTE: *If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-I-P APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 120.*

POWER OF ATTORNEY

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (*List name and registration number*)

PAUL B. WEST, 18947
JOSEPH H. HANDELMAN, 26179
JOHN RICHARDS, 31053
13 — JOHN J. CRYSTAL, 26360
RICHARD J. STREIT, 25765
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THOMAS F. PETERSON, 24790
RICHARD P. BERG, 28145
JULIAN H. COHEN, 20302
WILLIAM R. EVANS, 25858

(check the following item, if applicable)

☐ Attached as part of this declaration and power of attorney is the authorization of the above-named attorney(s) to accept and follow instructions from my representative(s).

SEND CORRESPONDENCE TO

LADAS & PARRY
~~26 WEST 61ST STREET~~
NEW YORK, NEW YORK 10023

DIRECT TELEPHONE CALLS TO:
(Name and telephone number)

(212)708-1930

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE(S)

NOTE: *Carefully indicate the family (or last) name as it should appear on the filing receipt and all other documents.*

Full name of sole or first inventor

1-00 Kari *(GIVEN NAME)* _____ *(MIDDLE INITIAL OR NAME)* Kirjavainen *FAMILY (OR LAST NAME)*

Inventor's signature _____

Date 2.2.1998 **Country of Citizenship** Finland

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Post Office Address Kivenlahdenkatu 11 A 4, FIN-02320 Espoo, Finland

Full name of second joint inventor, if any

2-00 Jyri *(GIVEN NAME)* _____ *(MIDDLE INITIAL OR NAME)* Järvenkylä *FAMILY (OR LAST NAME)*

Inventor's signature _____

Date 2.2.1998 **Country of Citizenship** Finland

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Post Office Address Tapiontie 4, FIN-15870 Hollola, Finland

Full name of third joint inventor, if any

(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____

Date _____ **Country of Citizenship** _____

Residence _____

Post Office Address _____

_____

CHECK PROPER BOX(ES) FOR ANY OF THE FOLLOWING ADDED PAGE(S) WHICH FORM A PART OF THIS DECLARATION

☐ Signature for fourth and subsequent joint inventors. *Number of pages added* _____.

* * *

☐ Signature by administrator(trix), executor(trix) or legal representative for deceased or incapacitated inventor. *Number of pages added* _____.

* * *

☐ Signature for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR 1.47. *Number of pages added* _____.

* * *

☐ Added page for signature by one joint inventor on behalf of deceased inventor(s) where legal representative cannot be appointed in time (37 CFR 1.47).

* * *

☐ Added pages to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (C-I-P) application.

☐ Number of pages added _____

* * *

☐ Authorization of attorney(s) to accept and follow instructions from representative.

* * *

(If no further pages form a part of this Declaration, then end this Declaration with this page and check the following item:)

☒ This declaration ends with this page.